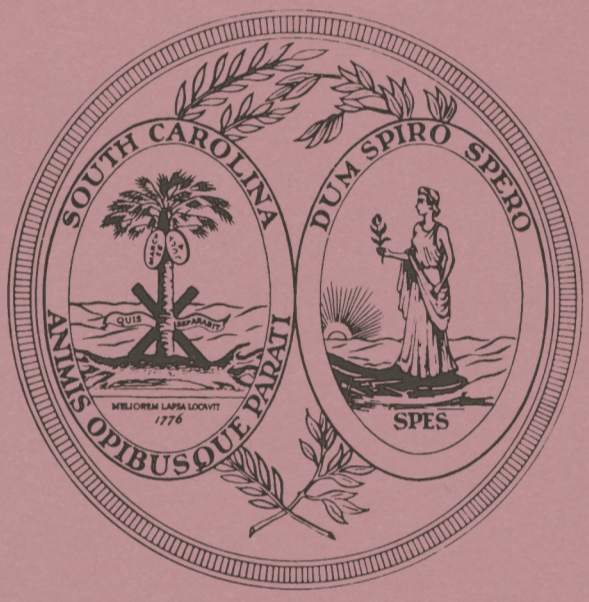
SOUTH CAROLINA
SEA GRANT CONSORTIUM



ANNUAL REPORT
1989-1990

Printed Under The Direction Of The
State Budget And Control Board

South Carolina Sea Grant Consortium

287 Meeting Street • Charleston, South Carolina 29401 • (803) 727-2078

Member Institutions
The Citadel
Clemson University
College of Charleston
Medical University of South Carolina
South Carolina State College
South Carolina Wildlife and Marine Resources Department
University of South Carolina

Chairman
Dr. Harry M. Lightsey, Jr.
President, College of Charleston

Executive Director
Margaret A. Davidson

September 25, 1990

The Honorable Carroll A. Campbell, Jr., Governor
The Honorable Members of the South Carolina
General Assembly

Your Excellency, Ladies and Gentlemen:

On behalf of the South Carolina Sea Grant Consortium and its Board of Directors, it is my pleasure to present to you the annual report of the S.C. Sea Grant Consortium for fiscal year 1989-1990, our tenth year of operation.

We appreciate your continued assistance and cooperation, and look forward to working with you during the next year.

Please do not hesitate to call on us if we can be of service.

Respectfully submitted,

THE S.C. SEA GRANT CONSORTIUM BOARD OF DIRECTORS

Dr. Harry M. Lightsey
Chairman

TABLE OF CONTENTS

The South Carolina Sea Grant Consortium

BOARD OF DIRECTORS

Dr. Harry M. Lightsey, Chairman
President
College of Charleston

Lt. Gen. Claudius E. Watts III
President
The Citadel

Dr. Max Lennon
President
Clemson University

Dr. James B. Edwards
President
Medical University of South Carolina

Dr. Albert E. Smith
President
South Carolina State College

Dr. James A. Timmerman
Executive Director
S.C. Wildlife and Marine Resources Department

Dr. James A. Holderman
President
University of South Carolina

Margaret A. Davidson
Executive Director

Member Institutional Liaisons

Dr. Michael B. Barrett
Dean of Graduate Studies
The Citadel

Dr. Chris Thurston
Office of University Research
Clemson University

Dr. Pat Green
Institute for Public Affairs and Policy Services
College of Charleston

Ms. Bonnie Williams
Coordinator of Research
Office of Research & Sponsored Programs
Medical University of South Carolina

Dr. Roy Isabel
Office of Research and Grants Administration
South Carolina State College

Mr. John Miglarese
Assistant Director
Marine Resources Div.
S.C. Wildlife and Marine Resources Department

Mr. Steve Etheridge
Sponsored Programs Administration
University of South Carolina

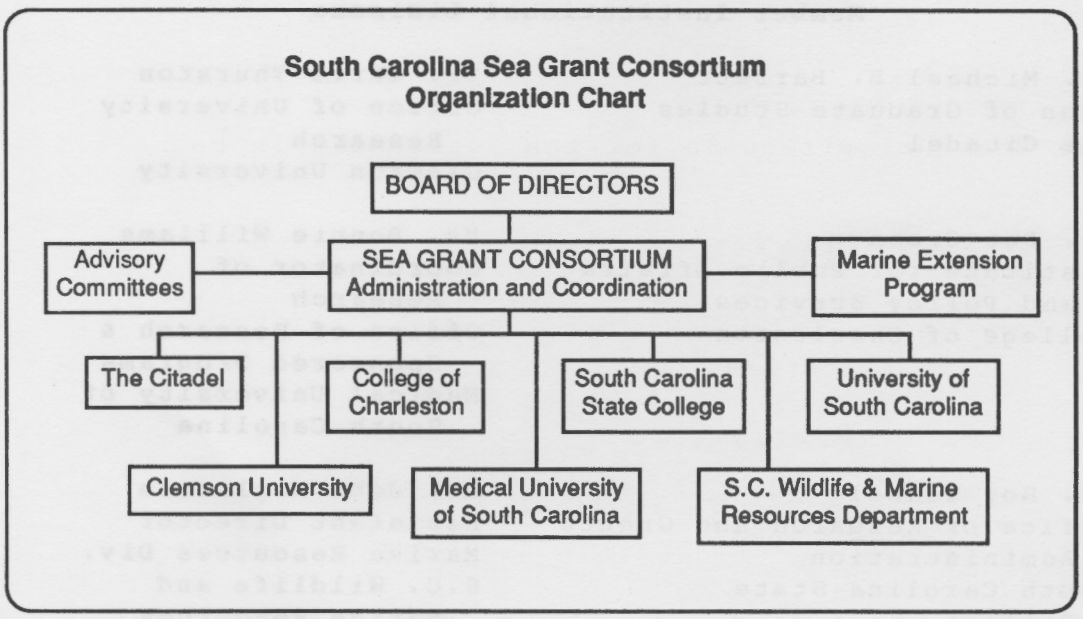
South Carolina Sea Grant Consortium

STAFF

Margaret A. Davidson, Executive Director.....Charleston
M. Richard DeVoe, Associate Director.....Charleston
Elaine L. Knight, Assistant Director.....Charleston
Judith B. Linder, Senior Accountant.....Charleston
Melvin Goodwin, PhD., Outreach Coordinator...Charleston
Monica L. Mulvey, Executive Secretary.....Charleston
Annette W. Dunmeyer, Word Processor Spec.....Charleston
Diana D. Alford, Research Assistant.....Charleston
Virginia Beach, Public Information Spec.....Charleston
John Tibbetts, Public Information Spec.....Charleston
Sandra T. Goodwin, Graphic Designer.....Charleston

MARINE EXTENSION PROGRAM

Melvin Goodwin, PhD., Coordinator.....Charleston
Jack Whetstone, Marine Extension Specialist..Georgetown
Robert Bacon, Marine Extension Area Agent.....Beaufort
Beth Day, Marine Extension Area Agent.....Horry



THE SOUTH CAROLINA SEA GRANT CONSORTIUM

Created by South Carolina Act No. 643 in 1978 (amended May 6, 1987, R106, H2331), the principal purpose of the South Carolina Sea Grant Consortium is to provide a mechanism for the development and management of the Sea Grant Program for the state of South Carolina and adjacent regions that share a common environment and resource heritage. The Consortium serves to support, improve and share research, education, training, and extension programs in fields related to ocean and coastal resources. The Consortium further encourages and follows a regional approach to solving problems or meeting needs relating to ocean and coastal resources in cooperation with appropriate institutions, programs, and persons in the region.

Charter Members

The membership of the Consortium consists of the College of Charleston, Clemson University, the Medical University of South Carolina, South Carolina State College, S.C. Wildlife and Marine Resources Department, The Citadel and the University of South Carolina. These members are designated as charter members.

The terms of the membership are perpetual, and a majority of the charter members may vote the admission of a new member into the Consortium.

Board of Directors

The Board of Directors for the Consortium is comprised of the chief executive officer of each of the participating educational institutions and state agencies or his designee.

Executive Director

The Board has the express power to employ the Consortium Director, who has the following powers and duties:

1. directs supervision over all Consortium proposals;
2. prepares Consortium proposals to be submitted to interested agencies;
3. prepares an annual summary of all submitted proposals;
4. negotiates funding levels for proposals submitted by member institutions;
5. provides an accounting to the board of the director's development funds;
6. requests and receives funds from local, state,

federal, and private sources for use by the director, Consortium, individual member institutions, or other persons;

7. gathers, maintains, and makes available to interested persons natural resource information from state and federal agencies, higher education institutions, and any other appropriate entity;
8. designates the location of the consortium office, subject to the approval of the board;
9. exercises all incidental powers necessary to carry out the provisions of this chapter.

Advisory Committee

The Sea Grant Director is to be assisted by an advisory committee which consists of seven members who serve for four-year terms. These seven people, representing private coastal and marine users, are to be appointed to assist the Director with the identification of statewide and regional constituent needs. To date, the advisory committee has yet to be selected and convened.

In addition, six program area advisory groups, consisting of two research professionals, two private sector representatives, and one public offical, assist in the identification of research projects and their incorporation into a cohesive program area package.

OVERVIEW

The South Carolina Sea Grant Consortium is a unique partnership of universities, colleges and one state agency working to promote and implement research, education and extension programs in the sphere of marine and coastal resources. The Consortium accomplishes these concurrent tasks by drawing on the diverse and extensive talents and expertise available at its seven constituent institutions:

* The Citadel
* Clemson University
* College of Charleston
* Medical University of South Carolina
* South Carolina State College
* South Carolina Wildlife & Marine Resources Department
* University of South Carolina

The Consortium is charged with bringing together and coordinating the diverse and extensive talents and expertise of its constituent institutions to assist the

state in resolving coastal and marine issues. Three distinct advantages are realized by this "partnership" mechanism:

* Duplication, often a problem in scientific research, is avoided by encouraging cooperation among the different institutions and among different disciplines within the institutions.

* The promotion of manpower sharing results in greater productivity and lower costs.

* The ability to put together teams of faculty and staff from the various member institutions to help solve problems of concern to the state maximizes the effectiveness of existing personnel at the lowest possible cost. Because of this, the South Carolina Sea Grant Consortium office can operate efficiently with a very small staff.

As an independent state agency, the Consortium has expanded its efforts in marine research programs, educational activities, and technical and extension services: it serves as a "broker" between its member institutions and those individuals, industries, and agencies that can benefit from the results of such a range of programs. The emphasis is placed on applied research based upon the needs identified by potential users; the information gained from Consortium activities is then transferred to those users. In other words, the Consortium acts as an information synthesis and dissemination clearinghouse.

The Consortium is responsible for the administration and management of the Sea Grant Program for the state of South Carolina. The National Sea Grant College Program, signed into law in 1966, awards competitive grants to some 31 coastal and Great Lakes states for the express purpose of accelerating the national development of marine resources, including their conservation, proper management, and economic utilization. It is through research, education and extension work that the objectives of the National Sea Grant College Program are implemented and realized.

The Consortium derives its major funding from several sources -- the state of South Carolina, the National Sea Grant College Program and other federal and private funding sources. Through an annual appropriation from the State, the Consortium receives funding to support the staff, program overhead, and the program development fund. The National Sea Grant College Program Office provides funding primarily for full-scale research, education, and extension service

projects. This commitment by both the state and the federal government in supporting the Sea Grant Consortium is representative of the cooperative nature of the Consortium as it addresses coastal and marine resource issues.

The Consortium is guided in its policy decisions at the state level by its Board of Directors. The Board, which consists of the chief executive officer of each of the Consortium's member institutions, meets regularly to review the Consortium's program and to propose new directions for broadening the scope of its activities.

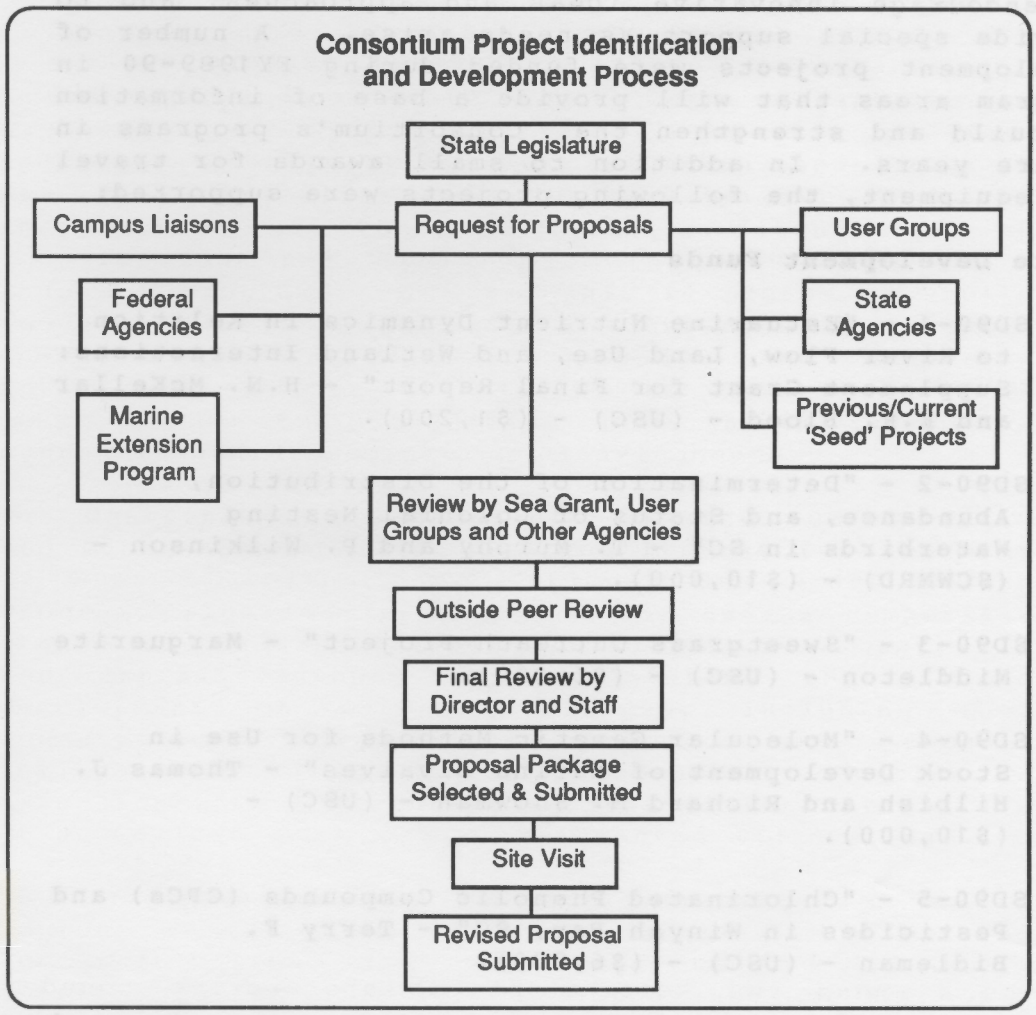
To facilitate administrative interaction between the Consortium and the faculty and staff of its member institutions, each institution has designated a liaison within its Sponsored Research or Financial Office. These liaisons provide a direct link between investigators and Consortium staff on matters dealing with the proposal process, processing of grants and awards, and oversight of ongoing projects and programs.

Actual research, education, and extension work on Consortium projects is, of course, carried out by the faculty and staff at the institutions. Their expertise and talent are strengths of the South Carolina Sea Grant Consortium; enabling it to meet the challenge of developing and managing coastal resources in an efficient and comprehensive fashion. Both faculty and staff approach this challenge from the variety of perspectives inherent in their multi-disciplinary fields.

In addition to providing professional expertise in many marine and coastal disciplines, member institutions are able to provide a wide range of facilities for use by Consortium project investigators. These investigators have access to more than 30 research laboratories, including those of the South Carolina Wildlife and Marine Resources Department at Fort Johnson and the James M. Waddell, Jr. Mariculture Research and Development Center in Victoria Bluff, and a large biomedical research facility of the Medical University of South Carolina. Six research vessels are available for field studies. Clemson University possesses the best agricultural engineering facilities for technological development and refinement in the state. Further, among the several field laboratories found throughout South Carolina, the University of South Carolina's 5000 square foot Belle W. Baruch Laboratory in Georgetown County provides a staff of twelve research associates and technicians with a fully equipped facility, including living quarters, and a large conference center.

PROGRAM DEVELOPMENT

The South Carolina Sea Grant Consortium has instituted a structured mechanism for its program identification and development process. Program areas are identified by the Consortium staff and program area advisors in consultation with state and federal natural resource agencies, private industry, and Marine Extension Program personnel. The project identification and development process outlined in the chart below is used in the development of the biennial proposal to the National Sea Grant College Program and, generally, for proposals to other funding sources.



For fiscal year 1989-90, the Consortium received some 22 initial proposals in response to its call for proposals. Review of these proposals by qualified professionals from academia, government, and industry throughout the United States via written evaluations and on-site meetings was followed by submission of invited, fully-developed proposals. These proposals were included in the Consortium's FY88-90 biennial proposal package to the National Sea Grant College Program Office for final review and consideration; seven proposals were subsequently funded. These are summarized in the next section.

In addition to federal Sea Grant project support, the Consortium Director is provided federal and state program development funds to allow for program flexibility and prompt response to high priority needs, to encourage innovative ideas and approaches, and to provide special support as needs arise. A number of development projects were funded during FY1989-90 in program areas that will provide a base of information to build and strengthen the Consortium's programs in future years. In addition to small awards for travel and equipment, the following projects were supported:

State Development Funds

A. SD90-1 - "Estuarine Nutrient Dynamics in Relation to River Flow, Land Use, and Wetland Interactions: Supplement Grant for Final Report" - H.N. McKellar and E.R. Blood - (USC) - ($1,200).

B. SD90-2 - "Determination of the Distribution, Abundance, and Status of Colonial Nesting Waterbirds in SC" - T. Murphy and P. Wilkinson - (SCWMRD) - ($10,000).

C. SD90-3 - "Sweetgrass Outreach Project" - Marguerite Middleton - (USC) - ($5,000).

D. SD90-4 - "Molecular Genetic Methods for Use in Stock Development of Marine Bivalves" - Thomas J. Hilbish and Richard M. Showman - (USC) - ($10,000).

E. SD90-5 - "Chlorinated Phenolic Compounds (CPCs) and Pesticides in Winyah Bay, SC" - Terry F. Bidleman - (USC) - ($6,900).

F. SD90-6 - "Charleston Harbor: Sediment Dynamics and Sub-Bottom Structures (NOAA Ship Ferrel, 1989)" - Thomas Tisue and Earl Hayter - (CU) - ($10,000).

G. SD90-8 - "SC Academy of Science" - Gordon Sproul - (USC) - ($500).

H. SD90-9 - "The Importance of Managed Wetlands as Critical Habitat for Migratory Shorebirds" - Chris Marsh - (USC-Coastal Carolina College) - ($6,300).

I. SD90-10 - "Enrichment Program for the 1990 Low Country Science Fair" - William Kubinec - (College of Charleston) - ($1,000).

J. SD90-11 - "South Carolina Marine Fishes - Educational Materials" - (SCWMRD) - ($2,500).

K. SD90-12 - "The Coastal Ocean Boundary Initiative Development Program" - Kevin Davis and John Miglarese - (SCWMRD) - ($13,000).

L. SD90-13 - "Policy Impacts of Climate Variability on the South Carolina Lowcountry" - Janet Key - (College of Charleston) - ($2,600).

M. SD90-14 - "Pathways of Sediment Transport Along the Inner Shelf of South Carolina as Elucidated by Geochemical Tracers" - Susan Libes - (USC-Coastal Carolina College) - ($800).

N. SD90-15 - "1990 ASIH, AES, SHNH, and SEFC Meetings" - Robert K. Johnson - (College of Charleston) - ($1,500).

Sea Grant Development Funds

A. P/M-2V (86-87) - "Computer Search of Published Literature on Beach Processes" - Earl J. Hayter - (CU) - ($500).

B. P/M-2W (86-87) - "Phytoplankton Ecology of Charleston Harbor Estuary After Hurricane Hugo, Sept. 21-22, 1989" - Phillip Dustan - (College of Charleston) - ($1,000).

C. P/M-2X (86-87) - "Underwater South Carolina" - Mel Goodwin - (SCSGC) - ($2,500).

D. P/M-2Y (86-87) - "Protection and Management Issues for South Carolina Wetlands" - Richard White - (CU) - ($2,500).

E. P/M-2h (87-88) - "Hurricane Hugo Phytoplankton Ecology: Summer Student Support" - Phillip Dustan - (College of Charleston) - ($3,200).

F. P/M-2J (88-89) - "Pilot Study of Blue Crab Settlement in Charleston Harbor" - Elizabeth Wenner and David Knott - (SCWMRD) - ($2,400).

G. P/M-2K (88-89) - "Trends Analysis of Coastal Tourism Supply Resources: South Carolina Study" - Thomas Potts and Muzaffer Uysal - (CU) - ($2,000).

H. P/M-2L (88-89) - "Sweetgrass Outreach Project" - Dale Rosengarten - (USC) - ($5,000).

SEA GRANT PROGRAM DESCRIPTION AND REVIEW

The South Carolina Sea Grant Consortium manages and administers the Sea Grant College Program for the State. As its primary responsibility, the Consortium develops a program that focuses on institutional research, marine education, and marine extension services. Since 1980, the Consortium has administered over $9 million in federal and state-appropriated funds for over 220 research, education and extension service projects. For the 1989-90 fiscal year, projects were funded at a combined federal-state level of over $1.3 million. More important, however, is the fact that major economic effects accrue to the state, the region, and, in many cases, the nation from these investments.

Institutional Research

Marine and coastal research programs undertaken by Sea Grant Consortium investigators are categorized into five program areas:

* Living Marine Resources
* Marine Environmental Research
* Coastal Resources Development and Management
* Bioengineering and Marine Technology
* Coastal Processes

During its first five years as a fully operational, independent state agency, the South Carolina Sea Grant Consortium gave preliminary consideration to a wide range of marine related projects. Beginning in FY1985-86, the Consortium's Program Proposal reflected a change in direction and a shift from broad, short-term projects to focused, long-term program areas. This transition implied a commitment to addressing major needs and concerns of coastal and marine users and managers through objective-oriented, integrated efforts.

This section provides the reader with a brief overview of the 8 fully developed proposals selected, grouped into the five program areas.

LIVING MARINE RESOURCES

The coast of South Carolina includes over 504,000 acres of wetlands and miles of tidal rivers and creeks, home to a number of important commercial and recreational species of finfish, shellfish and crustaceans. In addition to providing natural habitat for these important resources, South Carolina coastal waters include many areas in which a variety of species can be raised in aquaculture operations. In both instances, consideration must be given to maintaining high quality habitats, ensuring access to these areas, and balancing the needs of fishermen, aquaculturists and other resource users.

The South Carolina Sea Grant Consortium has organized its aquaculture and fisheries research programs under the Living Marine Resources program area in recognition of these mutual needs.

Aquaculture

The development of aquaculture has evolved slowly in the United States as compared to other countries of the world, where aquaculture plays a significant role in their economies. With growing U.S. consumer desire for seafood exceeding domestic supply, the concept of aquaculture has been gaining national attention. This is true for South Carolina where a variety of species, including hard clams, marine shrimp, crawfish, baitfish (minnows), catfish, and hybrid striped bass, are currently being cultured or examined because of their desirability for aquaculture. The potential for future aquaculture development is greatly enhanced due to the suitability of the climate, physiography, and other features of the state and region.

The South Carolina Sea Grant Consortium has and continues to conduct research and extension activities in support of aquaculture. These activities benefit from the James M. Waddell, Jr. Mariculture Research and Development Center at Victoria Bluff, South Carolina. The Center, which represents a significant commitment by the state to aquaculture, houses state-of-the-art facilities and equipment available to those conducting aquaculture research and extension activities. The Consortium works closely with the Center to improve opportunities for the private sector in their aquaculture pursuits.

Hard Clam Genetics Subprogram

The hard clam fishery (Mercenaria spp.) has suffered significant declines in total landings over the last

three decades despite high demand and correspondingly high value. Subsequently, the development of hard clam mariculture to supplement the over-exploited fishery has proceeded rapidly and today enjoys considerable commercial development and promise. To achieve economic feasibility, most commercial mariculture operations must rely on extensive field growout procedures for hatchery- and nursery-reared seed. These procedures, while cost effective for large scale operations, allow considerable loss of stock over the average three- to four-year growout cycle. Decreasing total field exposure time during growout would significantly increase economic returns. Growout data from South Carolina indicates that a 25 percent increase in growth rate could decrease field growout time by about eight months. This would make commercial hard clam mariculture much more attractive to investment because time to initial cash flow would be reduced and total return on investment would increase.

Genetic manipulation to produce faster growing cultivated stocks is a reasonable extension of aquaculture research with immediate application to commercial interests. Although some stock improvements in cultured clams have been derived through breeding programs at commercial facilities, no strict application of quantitative genetics to commercial-scale selected breeding has been performed. The potential for genetic improvements in hard clams is great considering their ease of breeding and genetic manipulation, the large variation existing in unselected wildstock, the availability of related species for hybridization, high individual fecundity, and the existence of selected stocks from commercial and research facilities. These attributes, coupled with results of previous and ongoing studies, indicate that a large and rapid improvement in growth and survival of hard clam stocks through genetic manipulation is within the capabilities of present technology.

The main objective of the Hard Clam Genetics Subprogram is to produce improved stocks of hard clams suitable for reliable and efficient culture. Secondary goals are the development of technology to improve breeding and culture methodologies, and the accumulation of information on molluscan physiology, genetics, and reproductive biology. This Subprogram is accomplishing these goals through an interdisciplinary, multi-institutional approach involving three cooperative research projects, each focused on specific elements of the overall problem:

(1) **R/A-15** - Breeding Phase and Effects of Allozyme Variation on Growth and Survival (J.J. Manzi, SCWMRD, Marine Resources Research Institute, and R. T. Dillon, College of Charleston): This project performs the basic breeding to produce experimental stocks for evaluation, collects and analyzes growth and survival data, and evaluates relationships between specific allozymes or combinations of allozymes and growth and survival of populations. In the first three years of this effort, three breeding strategies were pursued: induction of heterozygosity through outcrossing of hatchery-produced stocks, directed breeding of South Carolina wildstock, and hybridization of M. mercenaria with the closely-related southern quahog, M. campechiensis. In the fourth year, new research elements were introduced and included induced polyploidy and further investigation into the disirability of heterozygosity, inbreeding, and hybridization. This year and next, the breeding program will produce the F_4 generation, continue experiments with family selection, and will explore the effects of induced polyploidy.

(2) **R/A-18** - Gametogenesis and Early Life History (A. G. Eversole, Clemson University): This project is investigating the possibility that increases in growth rates in genetic stocks occur through partitioning of energy from reproduction to growth. Specific objectives for this year and next are to: (1) determine gametogenesis and fecundity of cultured stocks, polyploids and hybrids; and (2) determine the optimum conditioning window for cultured stocks used in the breeding program.

(3) **R/A-22** - Genetic Potential for Improved Productivity in the Hard Clam, Mercenaria mercenaria (Thomas J. Hilbish, University of South Carolina): This related project is dedicated to measuring the quantitative genetics of production in Mercenaria. Specific objectives for current work are to test the hypotheses that: (1) there is significant genetic variation for production traits in the hard clam; (2) artificial selection for improved productivity will result in negative selection for other desirable traits in Mercenaria; and (3) the magnitude and nature of genetic variation for production traits depends upon on the environment in which the animals are cultured.

The program has received considerable direction from meetings of principal investigators with geneticists

already working with bivalves (Gary Newkirk, Dalhousie University; Laura Adamkewicz, George Mason University; Richard Koehn, SUNY, Stonybrook; John Crenshaw, Georgia Tech). Principal investigators meet quarterly to evaluate status of the projects and suggest alterations in methodology or direction. A mid-program panel review of the entire program was held in December 1986 to provide outside evaluation of the subprogram. This panel of SCSGC reviewers included Don Squires (University of Connecticut), John Kraeuter (Baltimore Gas and Electric), Laura Adamkewicz (George Mason University) and Dennis Hedgecock (University of California). Program goals and progress in achieving these goals are thus reviewed regularly and revisions made when appropriate. Feedback from projects investigating allozyme variation, reproductive cycles and physiological performance guides the breeding phase of the program in choosing the most advantageous strategies to pursue and in discontinuing strategies which are not proving productive.

The Hard Clam Genetics Subprogram is highly interdependent. The associated projects on allozyme variation, reproductive analyses, and physiological assessment could not exist without the breeding project, which produces the lines for analysis. The breeding program's success depends on feedback from those associated projects to evaluate the success of different breeding strategies. In addition to this necessary interdependence, the interdisciplinary approach of the hard clam genetics subprogram assures that considerable information on the physiology, genetics and reproduction of the hard clam will be derived even if none of the breeding schemes successfully produces improved strains. This large body of information will improve our understanding of the biology of bivalves in general and may lead to improved techniques for breeding and culture which will be of value to commercial mariculture and fishery management.

Other Aquaculture

The aquaculture of finfish has shown great promise in South Carolina, and has been the source of innovative cooperation between the public and private sectors. Indeed, techniques developed and information derived from South Carolina Sea Grant support of hybrid striped bass research are now being used by culturists in Maryland, Virginia, North Carolina, Georgia and other states where hybrid bass culture is permitted. The overall goal of a continuing effort (**R/A-17 Smith**, SCWMRD, Marine Resources Research Institute) is to complete the development and demonstration of the

potential for striped bass/white bass hybrid aquaculture. With previous Sea Grant support, the investigator has demonstrated out-of-season spawning of captive brood stock and has produced fingerlings in intensive nursery systems. This four-year effort completed the evaluation by documenting the production levels and economic potential of culturing hybrid bass in ponds. Project tasks and results will be integrated with those currently supported by the University of North Carolina Sea Grant College Program. It is anticipated that a culture system will be demonstrated for rearing brood stock striped bass from eggs to maturity under completely controlled indoor conditions, and for control of the spawning cycle to produce fry out-of-season. Further, production levels attained by striped bass/white bass hybrids reared under different salinity and population density conditions will be obtained; corresponding economic analyses will be conducted. This project should result in a complete analysis of the aquaculture potential of hybrid bass culture in the Southeast.

MARINE ENVIRONMENTAL RESEARCH

Continued interest in the marine and coastal environment is based primarily on its natural resource potential and economic value. Exploitation of the various resources available along the coast has led to increasing demand and competition for the right and access to those resources. Coupled with increased utilization -- e.g., industrial development, agriculture, shipping, fishing, and recreation -- impacts on the marine environment, in one form or another, are inevitable. Encouraging harmony among all users of the coast and the marine environment must be one of the overall goals of managers responsible for ensuring the wise use and controlled development of the state's natural resources.

The South Carolina Sea Grant Consortium is committed to providing information and data to natural resource agencies and users for use towards minimizing and mitigating environmental effects resulting from these increasing pressures. A major area of concern has been identified by the Consortium - the study of estuarine systems - that forms the basis for the marine environmental research supported in FY89-90.

Estuarine Subprogram

Estuaries of the United States are considered one of the most productive ecosystems in the world: significant economic development depends on the maintenance of high quality estuarine systems. Many

commercially- and recreationally-important fisheries species spend at least a portion of their life cycle in estuarine environments. Estuaries serve as buffer zones between freshwater riverine systems and the coastal ocean. They receive and process large inputs of freshwater, sediments, nutrients, and other materials that drain from terrestrial-based watersheds. However, the physical, chemical, and biological processes that control these functions are far from being adequately understood.

At recent symposia designed to develop research strategies and management options for U.S. estuaries ("Research for Managing the Nation's Estuaries," Raleigh, NC, March 13-15, 1984; "Estuarine Management Practices," Baton Rouge, LA, November 12-13, 1985), five basic categories of research were identified: water inflows, sediment inflows, nutrients and other chemicals, the coupling of primary and secondary productivity, and fisheries habitat. These areas have been re-emphasized in NOAA's Estuarine and Coastal Ocean Science Framework. The South Carolina Sea Grant Consortium has identified priority needs for its Estuarine Subprogram within the research framework established through these sessions.

The primary focus of the Consortium's Estuarine Subprogram is on Charleston Harbor Estuary. Charleston Harbor, formed by the confluence of the Ashley and Cooper Rivers, is part of the second largest watershed on the East Coast (Santee-Cooper Watershed = 16,800 square miles). The Harbor is the site of major military, port, industrial, commercial, resort, and residential activities. It has also been influenced by two major engineering projects: diversion of 80% of the freshwater flow out of the system and into the Santee River in 1942; and rediversion of 80 percent of these waters back into the system in 1985. As a result, Charleston Harbor Estuary presents a unique opportunity for the examination of a highly-dynamic and heavily-impacted system.

The scope of the Sea Grant Consortium's Estuarine Subprogram has focused on elucidating the physical and biological nature of estuaries. At present, Consortium efforts have been strengthened through collaboration with the NOS Office of Oceanography and Marine Assessment, which is collecting data on current and tide fluctuations through the deployment of RADS technology in the Harbor. Additionally, monies provided through the NOAA Office of Ocean and Coastal Resources Management are supporting several efforts to characterize the biological, physical and chemical attributes of the estuary. Recent Sea Grant studies

have concentrated on the utilization and diet of estuarine habitat by penaeid shrimp, and the influences of physical processes, such as circulation and dispersion, on biological processes. The Consortium augmented its efforts in FY88-89 by adding two components to further characterize the Charleston Harbor estuarine system. These investigations focus on nutrient dynamics and the response of wetlands to changes in freshwater flow.

Estuarine scientists recognize that physical processes affect species recruitment and habitat utilization, species composition and productivity, nutrient dynamics, sediment transport, and pollutant transport and dispersion. It is, therefore, extremely important that these physical processes, including their variability, are understood. The third and fourth years of a continuing effort (**R/EM-5 Kjerfve,** University of South Carolina) will attempt to complete the characterization of the physical oceanographic conditions in Charleston Harbor. Objectives for this year and next are to: (1) simulate estuarine responses to changing freshwater flow, rising sea level, tides, and meteorological forcing; (2) measure, model and verify time and space variations in salinity; (3) identify and characterize dominant dispersion mechanisms; (4) calculate material fluxes along the river-estuary system and between the estuary and adjacent wetlands; and (5) estimate local material sources and sinks along the estuarine salinity gradient. The results of these oceanographic studies in Charleston Harbor Estuary will provide the basis for an improved understanding of the inherent biological and chemical variability in estuarine systems, critical for any attempts to manage the resource and man's impact upon it.

The rapid and continued commercial and residential development around the Charleston Harbor Estuary will undoubtedly affect water quality. Human activities and natural processes influence the distribution and dispersion of nutrient elements. The rediversion of the Cooper River with its increased freshwater flow will also modify nutrient inputs. However, little basic information exists on the nutrient dynamics of the estuary, making it difficult for managers to predict the potential water quality changes associated with increased anthropogenic inputs. The second and third years of a four-year project (**R/EM-6 McKellar and Blood,** University of South Carolina) proposes to develop an ecological-water quality model for the Cooper River portion of the estuary, placing special emphasis on the relationships among river discharge, non-point source loading and river-wetland

interactions. Objectives to (1) develop preliminary models of estuarine water quality dynamics by merging existing information on carbon and nutrient distributions with that on wetland distributions and estuarine hydrography and (2) quantify the functional role of selected watersheds and their dominant wetland habitats in modifying estuarine distributions of water quality parameters. These efforts will lead to the integration of resultant information with existing water quality and estuarine ecology models towards the development of a comprehensive management tool for the estuary.

The Cooper River rediversion has resulted in a reduction in freshwater discharge from 423 to 130 m/s. As a result of reduced freshwater runoff, the isohalines in the Cooper River portion of the estuary have significantly shifted upstream, resulting in a shift in the boundary between fresh and salt water intertidal wetlands. The remaining two years of a three-year study (**R/ER-7 Morris**, University of South Carolina) initiated in September 1989 will examine the effects of the changing salinity regime upon intertidal macrophyte wetland communities. The project will (1) develop and apply a salt balance model for intertidal sediments on the Cooper River, (2) determine species composition and biomass of intertidal wetland communities on the Cooper River in relation to the history of freshwater discharge, flood frequency and salt intrusion and (3) determine rates of methanogenesis from intertidal sediments in relation to salinity. The information gained in this project will offer a means of predicting how macrophyte communities will change in response to increased salt water intrusion, and how their productivity will be affected during the transition. It will also provide preliminary information necessary to predict the longer term effects of sea level rise.

COASTAL RESOURCES DEVELOPMENT AND MANAGEMENT

Coastal resource management issues in South Carolina are of the utmost importance to coastal zone planners, managers, developers, and those involved in commerce, industry, recreation, and tourism. The state has an approved Section 306 Coastal Zone Management Program which is administered by the South Carolina Coastal Council to encourage the preservation and wise development of coastal and marine resources. The Program seeks to balance the needs of many diverse interests and thereby avoid use conflicts.

The South Carolina Sea Grant Consortium plans to continue examining coastal management issues in

cooperation with the S.C. Coastal Council, other management agencies, and coastal user- groups. Research, education, and extension projects dealing with economics, policy, law, regulation, preservation, and development of the coast will provide the basis for the development of future Consortium efforts. Needs of the state and region will thus be served simultaneously in terms of coastal decision-making, planning, and assessment.

BIOENGINEERING & MARINE TECHNOLOGY

In an increasingly competitive economy, industry spends billions of dollars each year on the research and development of new and better products. Recently, attention has been focused on the exploration of marine sources for these products. These explorations have been enhanced by the creation of a field of scientific activity called biotechnology. Arising out of new developments in molecular biology and biochemical engineering, advances in biotechnology have allowed scientists and researchers to study biological phenomena as they apply to the manufacturing and service industries. Biotechnology research within the marine environment has focused on the effect of technological processes upon marine organisms and the effect of these organisms and their metabolites upon marine technologies. Already, marine biotechnology research has made significant contributions to the energy, food, pharmaceutical, biomaterial and pollution control industries.

This year, the South Carolina Sea Grant Consortium will continue to support research that seeks to advance anti-scalant and anti-foulant technologies that are based upon the properties of natural inhibitors of mineralization.

Every year the shipping and fishing industries, private boat owners and bridge maintenance crews spend millions of dollars and hundreds of hours controlling and removing scale and fouling organisms from their vessels and structures. Similar scaling problems occur in the fields of dentistry and medicine, particularly with teeth and prosthetic devices. To date, no biologically-safe and effective substance has been found to alleviate this phenomena. However, in the final two years of a four-year effort (**R/MX-5 Wheeler**, Clemson University) will complete the development of new anti-fouling and anti-scaling technologies using inhibitors of $CaCo_3$ crystallization. Specifically, he is conducting research to (1) improve the extraction procedures for the inhibitors, (2) test the efficacy of these new inhibitors, (3) evaluate and test synthetic

analogues of these inhibitors, and (4) identify anti-scalants of other minerals. The research should lead to the development of patents related to the new technologies, and additional support and collaboration from the industrial sector for the development and marketing of these new technologies to control scaling and fouling organisms.

COASTAL PROCESSES

The coastal zone of South Carolina can be divided into three segments. The morphology of the coast is typically represented as a transition zone between the North Carolina and Georgia coastlines. From the North Carolina border to Winyah Bay, the Coast is an arcuate strand, with broad sandy beaches, few inlets, well-developed dunes and sparse salt marshes. It is an area which includes a significant tourism and recreation industry in Myrtle Beach, and an industrial base in Georgetown. The southern section of the coast is dominated by a series of barrier islands, separated from the mainland by miles of tidal creeks and wide areas of salt marsh. There are few dune systems; rather, tidal inlets are prevalent. Population and industrial growth along this coastal region has remained slow due to these features. However, the numerous barrier and sea islands have attracted vacationers and tourists, and form the hub of the resort industry. The central portion of the coast retains characteristics of both the northern and southern sections; it is also the major permanent population center in the South Carolina coastal zone.

The South Carolina coast is fronted by 159 miles of beach (=10,000 acres) and 40 barrier islands. As a result of storms, rising sea level, and high rainfall and other natural events, waterfront property is continually subjected to unpredictable erosion and accretion cycles, inlet migrations, and other physical changes. The coast of South Carolina represents an area of primary economic, social, and environmental importance. The South Carolina Sea Grant Consortium seeks, in examining coastal process questions, to address the needs of residents who live and work along the coast by providing information on the natural processes that affect their property and livelihood.

Marine Outreach Programs

The Marine Outreach Program represents the Consortium's overall commitment to provide information to public and private constituents concerning use and management of coastal resources. Projects in education and extension services were the focus of the Consortium's outreach program during FY1989-90.

Marine Extension Program

The South Carolina Extension Program (MEP) was reorganized in 1987 to more effectively provide advisory services to the coastal community. In the restructured program, the South Carolina Sea Grant Consortium continues the cooperative arrangement with the Clemson University Cooperative Extension Service (CES). Program direction and oversight are maintained by the Consortium while CES provides the basic extension personnel and work plans to support general constituent needs. Other more specific needs are addressed through specialist projects within Consortium member institutions. This structure allows the MEP to maintain a core unit of permanent personnel under CES while also having the flexibility to contract experts for specific extension needs.

The Marine Extension Program has defined four primary program areas to respond to coastal user needs:

* food production
* coastal development
* marine-related industries
* marine education and information services

Within these areas MEP activities are targeted toward alleviating problems posed by inadequate understanding of coastal resources and appropriate use technologies, as well as hazards inherent to various uses of the coastal environment. Information delivery is closely coordinated with the Consortium's Communications and Information Services program.

The South Carolina Marine Extension Program designs its activities to meet the needs of marine resource users and provides the information necessary to ensure wise and effective use of South Carolina's marine resources. Through MEP's identification of needs, research efforts can be identified and conducted in a responsive and efficient manner. MEP cooperative efforts in the development of new technology and provision of extension services to coastal and marine-related businesses will enhance the sound growth of the economy of South Carolina, as well as sustained management of the coastal resources essential to this growth.

Recent program accomplishments include: establishment of the Charleston Harbor Estuary Citizens' Committee; development of educational materials on wetlands; coordination of the inaugural "Lowcountry Seafood Festival"; prepared a videotape production entitled "Keepers of the Coast" to improve public understanding of the role of traditional resource users; organization

and sponsorship of the South Carolina Aquaculture Forum; preparation of an MEP booklet on commercial crawfish culture; participation in the preparation of the South Carolina Aquaculture Plan; development of two crawfish production budgets available on computer software; development of "How to Build a Dune" slide show; completed a microcomputer-based expert system to evaluate the vulnerability of residential building designs to wind damage; holding of the second annual Coastal Growth Industries Forum; and assistance with the development of "Underwater South Carolina" as a vehicle for educating the public on underwater attractions. In addition, the MEP works closely with other Sea Grant programs, the SEMAS network, the National Marine Fisheries Service, other state and federal agencies, and others to provide timely delivery of practical information to various user groups and the general public.

Communications and Information Services Program

The Communications Program is designed to compliment the Marine Extension Program by producing and distributing appropriate information products, attending coastal festivals, and through other public information vehicles that reach coastal constituents. All Communications projects attempt to relate the complex and fragile nature of our coastal resources and promote public awareness of important coastal issues and opportunities.

Specific goals of the Communications Program are to: identify specific user groups and respond to their needs with appropriate information products, increase public awareness of Consortium research and the Marine Extension Program, establish consistent and continuous contact with Consortium constituents, improve media familiarity and coverage of the Consortium, and develop support materials for Consortium festival and event appearances.

Examples of CIS activities during FY 1989-1990 include:

Program Awards

The Consortium and CIS earned national and state awards in 1989 and 1990. In July 1989, CIS staff received a Take Pride in America national award from President Bush and Interior Secretary Lujan for coordinating South Carolina's first state-wide beach cleanup and marine debris education campaign.

In January 1990, the S.C. Wildlife Federation selected the Consortium as the winner of its Communications

Conservationist Award for outstanding work in conservation education. The Consortium's quarterly newsletter Coastal Heritage, the annual winter conference, Beach Sweep, and various publications on the coastal environment were some of the key activities considered for the award.

Media Education

The Consortium's Communications Program:

* placed 5 marine science feature stories
* placed 12 radio PSAs
* gave 6 television interviews
* provided 6 radio interviews
* gave 19 newspaper interviews
* contributed to another 11 stories

Aquaculture

Communications published Coastal Heritage - "Aquaculture in South Carolina" as its Fall 1989 issue, and developed promotional materials for the 1989 Aquaculture Forum, 1990 Hybrid Bass Workshop and 1990 State Aquaculture Conference.

Economic Development and Resource Management

Communications published the Report of the Governor's Freshwater Wetlands Forum, Recycle, South Carolina!, a guide to recycling in the state and assisted in the development of "Our Valuable Wetland Resources" slide show and presentation.

Coastal Processes

Communications published Coastal Heritage - "Climate Change" as its Winter 1990 issue, The Risk of Hurricane Wind Damage to Buildings in South Carolina in cooperation with MEP, and Hurricane Preparedness Checklists in cooperation with MEP. The program also developed "How to Plant A Dune" slide presentation (with MEP) and coordinated a state-wide conference on Climate Change.

Marine Education

Communications coordinated the state-wide Beach Sweep '89, developed "Cleaning Up Our Act" slide show (with MEP), gave 12 group presentations and exhibited at six public events.

Other Extension Projects

The South Carolina Sea Grant Program has committed significant resources to aquaculture research and development and technology transfer over the last ten years.

For the last six years, the Consortium has supported the development of hybrid striped bass aquaculture. In 1988, under the MEP "Core" project, a four-year hybrid striped bass extension effort (Smith, under A/E-1) was initiated. The primary objective of the effort is the transfer of existing hybrid bass culture technology from the research community to the private sector. Entering its third year, the hybrid bass extension project has developed cooperative programs with eight private farmers in South Carolina, using a combination of on-site training and special workshops. The investigator (**A/O-4 Smith**, SCWMRD, Marine Resources Research Institute) has been (1) providing management recommendations to the eight growers, (2) demonstrating hands-on hatchery procedures, (3)demonstrating pond stocking and harvesting techniques and (4) providing marketing assistance. Over the next two years, the effort will include (1) conducting hybrid bass culture workshops for farmers and extension personnel, (2) preparing extension fact sheets and training videos and (7) summarizing and publishing results of the program.

Service to Other Public Agencies

The South Carolina Sea Grant Consortium has assisted other public agencies with several tasks during FY89-90. The Executive Director was selected to chair the Interagency Advisory Staff of the Joint Legislative Aquaculture Committee, which oversaw the development of the "Strategic Plan for Aquaculture Development in South Carolina," coordinated and published by the Consortium.

The Consortium also provided staff support to the Governor's Freshwater Wetlands Forum, published the Wetlands Forum Report and prepared an educational wetlands slide presentation package. Additionally, the Consortium prepared, produced and published "Recycle South Carolina" in conjunction with the Governor's Office.

In early 1990, the Consortium was asked to participate in the development of a State Hazards Mitigation Plan with the Governor's Office. This activity is still underway.

Other Grants and Activities

The Consortium supports a variety of programs and activities to meet its goal and objectives. Projects undertaken with Sea Grant support represent the core elements of the Consortium's programs. Pass-through grants and extramural projects are initiated to complement the Sea Grant effort at this time; the future of the Consortium lies in its ability to increase its non-Sea Grant program support.

For fiscal year 1989-1990, the S.C. Sea Grant Consortium obtained funding support from the following organizations for the following activities:

1. **Gulf and Caribbean Fisheries Institute**

   * "GCFI Proceedings for 1987 and 1988" - Dr. Mel Goodwin (SCSGC) - FY89 - $7,000.

2. **National Sea Grant College Program (NOAA)**

   * "Support for Sea Grant Federal Fellows Program/Dean John A. Knauss Marine Policy Fellowship" - Margaret A. Davidson (SCSGC) - $30,000.

3. **Office of Oceans and Atmospheric Research - NOAA**

   * "Continuation of Sediment - Water Interface Studies" - Dr. Thomas Tisue (Clemson) - October, 1989 - NOAA Ship FERREL. Value = $56,000 (approx.)

4. **U.S. Army Corps of Engineers**

   * "Support for Conferences on the Effects of Hurricane Hugo" - Margaret A. Davidson (SCSGC) - $4,000.

5. **Governor's Office of Energy, Agriculture and Natural Resources**

   * "South Carolina Recycling Guide" - Margaret A. Davidson (SCSGC) - $10,000.

   * "Report of the Governor's Freshwater Wetlands Forum" - Margaret A. Davidson (SCSGC) - $10,000.

6. **University of Miami**

* "Development of Information Products on Marine Resource Use in Anguilla" - Dr. Mel Goodwin (SCSGC) - $4,000.

7. **University of Rhode Island**

* "Publication of the CAMPNET Newsletter" - Dr. Mel Goodwin (SCSGC) - $560.

8. **City of Charleston - Commissioners of Public Works**

* "A study of Impacts Resulting from Pipeline Installation and Mitigation Efforts on Selected Saltmarsh Ecosystem Components in the Ashley River and Wappoo Creek" - Dr. Mel Goodwin (SCSGC) - FY89 - $41,518.

9. **Joanna Foundation**

* "Development of Curricula for a Course on Coastal Resources Issues and Concerns" - Margaret A. Davidson (SCSGC) - $2,000.

10. **Junior League of Charleston**

* "Public Awareness Project for Charleston Harbor" - Dr. Mel Goodwin (SCSGC) - $500.

11. **Private Funds (misc.)**

* "Determination of the Distribution, Abundance, and Status of Colonial Nesting Waterbirds in South Carolina" - Mr. Thomas M. Murray and Mr. Philip M. Wilkinson (SCWMRD) - FY89 - $5,825.

* "Hybrid Striped Bass Aquaculture Demonstration Project" - Dr. Ted Smith (SCWMRD) - $23,990.

EFFICIENCY AND EFFECTIVENESS MEASURES

The South Carolina Sea Grant Consortium, in accordance with the requirements of Act 189, Section 129.50, have developed the following efficiency and effectiveness measures. Insomuch as the requirements were established in Proviso 129.50 of the FY89-90 Appropriations Act, and their development was requested in December 1989, complete data are not available for comparisons of performance.

Overall Mission Statement

To develop, support, improve and coordinate research, education, training and extension efforts that enhance the economic development, proper management and conservation of coastal and marine resources in the State and region, through administration of the Sea Grant Program and in cooperation with appropriate institutions, programs and persons in the region.

Program Title:

Administration

Program Performance Measures:

Effectiveness:

1. Contacts made through mass media efforts in FY89-90 over previous year.

Performance:

Number of Media Placements (FY89-90) = 438
Number of Media Placements (FY88-89) = 152

2. Public school science teachers and students exposed to and/or using marine education materials in FY89-90 over previous year.

Performance:

Number of Teachers/Students (FY89-90) = 1,726
Number of Teachers/Students (FY88-89) = 1,108

3. Requests for assistance received by Consortium during FY89-90 compared to previous year.

Performance:

Records to be kept starting in FY90-91.

4. Number of and enrollment at MEP workshops and demonstrations during FY89-90 compared to previous year.

Performance:

Number of Workshops (FY89-90) = > 85
Attendees (FY89-90) = >7,500

5. Sea Grant project proposals reviewed by the National Sea Grant College Program Office that are deemed technically and conceptually sound in FY90-92 compared to previous biennial cycle (FY88-90).

Performance:

Percent of Proposals (FY90-92) = 88.9%
Percent of Proposals (FY88-90) = 81.3%

6. Investigators, professionals and students supported through Sea Grant research, extension and education projects in FY89-90 compared to previous year.

Performance:

Number of Investigators (FY89-90) = 22
Professionals (FY89-90) = 14
Students (FY89-90) = 24
Number of Investigators (FY88-89) = 24
Professionals (FY88-89) = 18
Students (FY88-89) = 20

7. Percentage change in non-state program budget (research, extension and education activities) in FY 89-90 over previous year.

Performance:

Non-State Funds (FY89-90) = $935,305
Non-State Funds (FY88-89) = $883,700

Efficiency:

1. Ratio of non-state financial support to state financial support.

Performance:

Ratio (FY89-90) = +53.8%
Ratio (FY88-89) = +53.7%

2. Average cost per constituent contact (based on the ratio of costs and distribution of publications to the cost of the Communications program).

Performance:

Cost per Constituent (FY89-90) = $0.90

FISCAL REPORTS

Contents

Exhibit A

S.C. Sea Grant Consortium
Balance Sheet
June 30, 1990

Assets			Liability and Fund Balance		
Current Funds:			Current Funds:		
Cash on hand	$ 200		Unrestricted	$	
Prior year refund	108		Prior year refund	108	
State Treasurer	372		Due to State General Fund	572	
		$ 680			$ 680
Restricted Funds:			Restricted Funds:		
Due from Grantors	678		Revenue	165,220	
State Treasurer	165,220		Deferred Revenue	678	
		165,898			165,898
Total Funds		$166,578	Total Funds		$166,578
Fixed Assets			Fixed Assets Funds		
Equipment Inventory	139,682		Funds Balance	139,682	
Total Fixed Assets Funds		$139,682			$139,682

Exhibit B

S.C. Sea Grant Consortium
Statement of Changes in Current Operating Funds
Year Ended June 30, 1990

	Administration
Balance July 1, 1989	$ 200
Additions:	
Original Appropriation	503,607
Salary & Fringe Benefits Adjustments	11,864
Vacancy Factor Reduction	(5,594)
Travel Reduction	(747)
Bonus Allocations	1,230
Total Additions	510,360
Deductions:	
Expenditures	509,988
Total Deductions	509,988
Balance Due to the General Fund	$ 572

Exhibit C

S.C. Sea Grant Consortium
Statement of Changes in Restricted Funds
Year Ended June 30, 1990

	Balance 7/1/89	Total Additions	Total Deductions	Balance 6/30/90
Sea Grant Contracts	$	$	$	$
1985-86		75	75	
1986-87		17,515	17,515	
1987-88		24,910	26,684	(1,774)
1988-89		320,317	327,230	(6,913)
1989-90		454,728	430,292	24,436
Other Restricted Funds	146,938	156,525	124,667	178,796
Totals	$146,938	$ 974,070	$ 926,463	$194,545

Exhibit D

S.C. Sea Grant Consortium
Statement of Changes in Fixed Assets
Year Ended June 30, 1990

	Balance 7/1/89	Total Additions	Total Deductions	Balance 6/30/90
Capital Equipment	$105,887	$15,314	$ 7,143	$114,058
Motor Vehicle Equipment	25,624			25,624
Totals	$131,511	$15,314	$ 7,143	$139,682

Exhibit E

S.C. Sea Grant Consortium
Notes to Financial Statements
June 30, 1990

Note 1 - Summary of Significant Accounting Policies

Basis of Accounting:

The financial statements have been prepared on an accrual basis.

Funding Accounting:

To ensure observance of limitations and restrictions placed on the use of resources available to the Consortium, the accounts are maintained in accordance with the principles of fund accounting. This is the procedure by which resources for various purposes are classified for accounting and reporting purposes into funds that are in accordance with specified activities or objectives. Separate accounts are maintained for each fund.

General Fixed Assets:

Fixed assets are recorded as expenditures of the general operating fund upon acquisition and subsequently capitalized at actual cost in the general fixed asset account group. In accordance with generally accepted accounting principles prescribed for governmental funds, a provision for depreciation of general fixed assets is not recorded.

Grant Accounting:

The Consortium is a State agency involved in ocean and coastal research, education, and advisory extension work. It serves to encourage, coordinate and facilitate projects pertaining to coastal and ocean areas of South Carolina and to utilize the talents of its members to address marine issues and opportunities.

The Consortium identifies these projects through planning and priority setting exercises. The Consortium arranges for the design and implementation of the projects, usually through its member institutions. On a biennial basis, core projects are submitted to the National Sea Grant Program for funding. Additionally, the Consortium submits project proposals to federal, state and private funding agencies for consideration and support. A majority of the projects funded are then subcontracted to various member institutions.

Expenditures paid by the Consortium at June 30 and not yet reimbursed by the primary grantor are recorded as accounts receivable. Revenues received on specific grants which are in excess of expenditures are recorded as deferred revenues.

Note 2 - Retirement Plan

Substantially all employees of the Consortium are covered by a retirement plan through the South Carolina Retirement System. It was not feasible to separately identify current year retirement plan cost included as a portion of employer contributions in the accompanying financial statements.

Information regarding the excess, if any, applicable to the Consortium of the actuarially computed value of vested benefits over the total of the pension fund and any balance sheet accruals, less any pension prepayments of deferred charges is not available. By State Law, the Consortium's liability under the retirement plan is limited to the amounts appropriated therefore in the South Carolina Appropriation Act, plus the amount paid from other revenue sources for the current year. Accordingly the Consortium recognizes no contingent liability for unfunded costs associated with participation in the plan.

Note 3 - Contingent Liabilities

The Consortium has numerous contracts with the Federal Government, other State agencies and other funding sources for the reimbursement of specific costs related to the various programs described in each contract. Reimbursement costs subsequently deemed to be unallowable by the grantor, if any, would have to be repaid. A majority amount of the contracts are in turn subcontracted by the Consortium and reimbursed costs deemed to be unallowable would result in a claim by the Consortium against the subcontractor.

Note 4 - Changes in General Fixed Assets

Changes in general fixed assets for the year ended June 30, 1990 are as follows:

	Balance 7/1/89	Additions	Deletions	Balance 6/30/90
Equipment	$131,511	$15,314	$ 7,143	$139,682

Schedule I

S.C. Sea Grant Consortium
Schedule of Current Unrestricted Expenditures
Year Ended June 30, 1990

Title	Original Appropriations	Revised Appropriations	Expenditures	Balance
Personal Services	$ 265,279	$ 250,004	$ 249,922	$ 82
Fringe Benefits	48,896	49,196	49,154	42
Contractual Services	50,684	40,308	40,259	49
State Development	50,000	64,400	64,392	8
Supplies	15,130	22,590	22,579	11
Fixed Charges	50,938	54,073	54,069	4
Travel	13,680	16,033	16,030	3
Equipment	1,000	7,706	7,535	171
Light, Power, Heat	5,000	4,310	4,309	1
Transportation	3,000	1,740	1,739	1
Total General Fund	$ 503,607	$ 510,360	$ 509,988	$ 372

Schedule I-A

S.C. Sea Grant Consortium
State Development Grants
Year Ended June 30, 1990

Title	Grantee	Expenditures
Estuarine Nutrient Dynamics	USC	$ 1,200
Bird Guide	SCWMRD	10,000
Molecular Genetic Methods	USC	10,000
CPC's & Pesticides-Winyah Bay	USC	6,900
NOAA Ship Ferrel	USC	10,000
Wetlands Education	USC	2,300
Academy of Science	USC-Beaufort	500
Shorebirds in Managed Wetlands	USC-Coastal	3,000
Science Fair	CofC	1,000
Fish Posters	SCWMRD	2,500
Coastal Ocean Initiative	SCWMRD	11,433
Climate Variability	CofC	2,600
Equipment - "Corer"	USC-Coastal	800
Meetings	CofC	1,500
Wetlands Slide Show	USC	659
Totals		$ 64,392

Schedule II-A

S.C. Sea Grant Consortium
Schedule of Restricted Expenditures
Sea Grant 1985-86
Year Ended June 30, 1990

	Printing	Totals
Development	$ 75	$ 75

Schedule II-B

S.C. Sea Grant Consortium
Statement of Changes in Restricted Expenditures
Sea Grant 1985-86
Year Ended June 30, 1990

	Balance 7/1/89	Total Additions	Total Deductions	Balance 6/30/90
Development	$	$ 75	$ 75	$

Schedule III-A

S.C. Sea Grant Consortium
Schedule of Restricted Expenditures
Sea Grant 1986-87
Year Ended June 30, 1990

	Contract Services	Sub-Contracts	Travel	Total
Administration	$ 417	$	$1,290	$ 1,707
Development	919	5,580		6,499
Sub-Contract*		9,309		9,309
	$ 1,336	$14,889	$1,290	$17,515

*Atlantic Bight - USC

Schedule III-A-1

S.C. Sea Grant Consortium
Sub-Contracts
Sea Grant 1986-87
Year Ended June 30, 1990

Title	Grantee	Expenditures
Michener - Travel/Data	USC	$1,240
Numerical Ocean Modeling	USC	4,340
Total		$5,580

Schedule III-B

S.C. Sea Grant Consortium
Statement of Changes in Restricted Expenditures
Sea Grant 1986-87
Year Ended June 30, 1990

	Balance 7/1/89	Total Additions	Total Deductions	Balance 6/30/90
Administration	$	$ 1,707	$ 1,707	$
Development		6,499	6,499	
Sub-Contract		9,309	9,309	
Total		$17,515	$17,515	

Schedule IV-A

S.C. Sea Grant Consortium
Schedule of Restricted Expenditures
Sea Grant 1987-88
Year Ended June 30, 1990

	Salaries	Fringe Benefits	Contractual Services	Sub-Contracts	Travel	Equip.	Total
Administration	$ 7,921	$ 1,646	$ 1,772	$	$2,936	$6,945	$ 21,220
Development*	1,260	96		976	837		3,169
Sub-Contracts**				(301)			(301)
NMPO				2,596			2,596
Total	$ 9,181	$ 1,742	$ 1,772	$ 3,271	$3,773	$6,945	$ 26,684

*Sweetgrass Conference Proceedings - USC
** R/MX-5- Clemson - refund

Schedule IV-B

S.C. Sea Grant Consortium
Statement of Changes in Restricted Grants
Sea Grant 1987-88
Year Ended June 30, 1990

	Balance 7/1/89	Total Additions	Total Deductions	Balance 6/30/90
Administration	$	$ 19,446	$ 21,220	$ (1,774)
Development		3,169	3,169	
Sub-Contracts		(301)	(301)	
NMPPO		2,596	2,596	
Totals	$	$ 24,910	$ 26,684	$ (1,774)

Schedule V-A

S.C. Sea Grant Consortium
Schedule of Restricted Expenditures
Sea Grant 1988-89
Year Ended June 30, 1990

	Salaries	Fringe Benefits	Contractual Services	Sub-Contracts	Supplies	Fixed Charges	Travel	Equip.	Total
Administration	$ 4,433	$ 1,882	$ 9,538	$ 2,075	$ 5,187	$	$ 4,987	$ (864)	$ 27,238
Development	3,104	280	1,633	4,039	215				9,271
Communications	5,417	1,417	12,912		5,853	141	50	889	26,679
Intern-Cunningham	11,813	1,800	4,484						18,097
Intern-Scholz	11,813	974	3,823						16,610
Marine Ext. Program	6,864	2,022		59,980	(22)	41			68,885
Sub-Contracts				160,450					160,450
Totals	$ 43,444	$ 8,375	$32,390	$226,544	$11,233	$ 182	$ 5,037	$ 25	$327,230

Schedule V-A-1

S.C. Sea Grant Consortium
Sub-Contracts
Sea Grant 1988-89
Year Ended June 30, 1990

Title	Grantee	Expenditures
Hard Clam Breeding: Breeding Phase	SCWMRD	$ 43,107
Hard Clam Breeding: Breeding Phase	CofC	4,742
Hard Clam Breeding: Gametogenesis	Clemson	12,530
Improved Productivity in Hard Clam Breeding	USC	21,699
Potential of Striped Bass/White Bass Hybrids	SCWMRD	14,600
Estuarine Flow	USC	25,531
Advances in Anti-Scaling/Anti-Fouling Technology	Clemson	38,241
Totals		$160,450

Schedule V-A-2

S.C. Sea Grant Consortium
Development
Sea Grant 1988-89
Year Ended June 30, 1990

Title	Grantee	Expenditures
Blue Crab Pilot Study	SCWMRD	$ 2,388
Coastal Tourism Trends Analysis	Clemson	566
Sweetgrass Basketmaking	USC	1,085
Total		$ 4,039

Schedule V-A-3

S.C. Sea Grant Consortium
Marine Extension Program Sub-Contracts
Sea Grant 1988-89
Year Ended June 30, 1990

Title	Grantee	Expenditures
Marine Extension Program	SCWMRD	$ 7,367
Marine Extension Program	Clemson	7,670
Marine Extension Program	Clemson	10,933
Marine Extension Program	USC	- 0 -
Marine Extension Program	SCWMRD	1,877
Marine Extension Program - Education	SCWMRD	14,360
Marine Extension Program	Clemson	17,773
Totals		$59,980

Schedule V-B

S.C. Sea Grant Consortium
Statement of Changes in Restricted Funds
Sea Grant 1988-89
Year Ended June 30, 1990

	Balance 7/1/89	Total Additions	Total Deductions	Balance 6/30/90
Administration	$	$ 22,784	$ 27,238	$(4,454)
Development		7,837	9,271	(1,434)
Communications		24,949	26,679	(1,730)
Intern Cunningham		18,097	18,097	-0-
Intern Scholz		16,610	16,610	-0-
Marine Extension Program		69,590	68,885	705
Sub-Contracts		160,450	160,450	
	$	$320,317	$327,230	$(6,913)

Schedule VI-A

S.C. Sea Grant Consortium
Schedule of Restricted Expenditures
Sea Grant 1989-90
Year Ended June 30, 1990

	Salaries	Fringe Benefits	Contract. Services	Sub Contracts	Supplies	Fixed Charges	Travel	Equip	Total
Administration	$ 12,421	$ 2,098	$ 13,149	$	$ 2,453	$ 5	$ 6,449	$ 809	$37,384
Sea Grant Abstracts				55,000					55,000
Development									-0-
Communications			24,385		8,985	842	1,800		36,012
Intern	6,063	935	4,127			7			11,132
Marine Extension Program	20,898	3,461	4,047	53,507	2,075	235	3,751		87,974
Sub-Contracts				202,790					202,790
Totals	$ 39,382	$ 6,494	$ 45,708	$311,297	$13,513	$1,089	$12,000	$ 809	$430,292

Schedule VI-A-1

S.C. Sea Grant Consortium
Sub-Contracts
Sea Grant 1989-90
Year Ended June 30, 1990

Title	Grantee	Expenditures
Applied Breeding of the Hard Clam	SCWMRD	$ 72,102
Applied Breeding of the Hard Clam	CofC	1,068
Applied Breeding of the Hard Clam	Clemson	6,669
Genetic Potential in the Hard Clam	USC	28,685
Assessment & Modeling of Estuarine Flow	USC	38,679
Estuarine Nutrient Dynamics	USC	16,339
Intertidal Wetland Responses	USC	22,161
Anti-Scaling/Anti-Fouling Technology	Clemson	17,087
Totals		$202,790

Schedule VI-A-3

S.C. Sea Grant Consortium
Marine Extension Program Sub-Contracts
Sea Grant 1989-90
Year Ended June 30, 1990

Title	Grantee	Expenditures
Marine Extension Program	SCWMRD	$ 12,087
Marine Extension Program	Clemson	7,472
Marine Extension Program - Education	SCWMRD	3,373
Marine Extension Program	Clemson	30,575
Totals		$53,507

Schedule VI-B

S.C. Sea Grant Consortium
Statement of Changes in Restricted Funds
Sea Grant 1989-90
Year Ended June 30, 1990

	Balance 7/1/89	Total Additions	Total Deductions	Balance 6/30/90
Administration	$	$43,296	$37,384	$ 5,912
Sea Grant Abstracts		55,000	55,000	
Development		602	-0-	602
Communications		48,715	36,012	12,703
Intern		12,001	11,132	869
Marine Extension Program		92,324	87,974	4,350
Sub-Contracts		202,790	202,790	
Totals	$	$454,728	$430,292	$ 24,436

Schedule VII-A

S.C. Sea Grant Consortium
Schedule of Other Restricted Expenditures
Year Ended June 30, 1990

	Salaries	Fringe Benefits	Contractual Services	Sub Contracts	Supplies	Travel	Total
Sale of Assets	$	$	$	$	$	$	$ -0-
Bird Guide			25	6,733	46		6,804
Beach/River Sweep	1,396	106	3,251		747	29	5,529
Communications Reprints							-0-
Educational Cruise			165				165
Anquilla/Coral Reef Poster			4,000				4,000
Coastal Issues Course			1,900		50	50	2,000
Public Awareness							-0-
PICMD-Caribbean							-0-
Mid-Winter Conf. Luncheon			750				750
Recycling Guide	225	17	14,132		179		14,553
Undersea SC '90			1,332		79		1,411
Earthday T-Shirts			720				720
CPW Pipeline	4,473	686		30,498			35,657
Hybrid Bass Workshop			58				58
WR3 Ecosystems				3,000			3,000
Wetlands Ed Material			6,363	6,969			13,332
PICMD-Donation			20				20
Hybrid Bass Donation				8,641			8,641
GCFI	4,947	919	2,076				7,942
Dive '89			(495)				(495)
PRT-Folly Beach							-0-
Shrimp Workshop			500				500
Dual Employment	6,261	872					7,133
OCRM				12,118			12,118
EPA			226		45		271
Coastal Impacts			558				558
Totals	$ 17,302	$2,600	$35,581	$67,959	$ 1,146	$ 79	$124,667

Schedule VII-B

S.C. Sea Grant Consortium
Statement of Changes in Other Restricted Funds
Year Ended June 30, 1990

	Balance 7/1/89	Total Additions	Total Deductions	Balance 6/30/90
Sale of Assets	$ 225	$ 1,505	$	$ 1,730
Bird Guide	16,292	3,325	6,804	12,813
Beach Sweep/River S	2,150	9,965	5,529	6,586
Communications Reprints	1,709	1,320		3,029
Education Cruise		165	165	
Anguilla/Coral Reef Poster		4,000	4,000	
Coastal Issues Course		2,000	2,000	
Public Awareness		500		500
PICMD - Caribbean	9			9
Mid-Winter Conf Luncheon		750	750	
Recycling Guide		14,738	14,553	185
Undersea SC '90		2,298	1,411	887
Earthday T-Shirts		720	720	
CPW Pipeline	40,461	49,187	35,657	53,991
Hybrid Bass Workshop		290	58	232
WR3 Ecosystems		3,000	3,000	
Wetlands Ed Materials	2,987	10,363	13,332	18
Econ Viability-St. Kitts	3,147		-0-	3,147
PICMD-Donation	299		20	279
Hybrid Bass Donation	71,858	24,485	8,641	87,702
GCFI	2,924	9,127	7,942	4,109
Dive '89	(495)		(495)	
PRT - Folly Beach	8			8
Shrimp Workshop	4,749		500	4,249
Dual Employment	464	6,669	7,133	
OCRM		12,118	12,118	
EPA	151		271	(120)
Coastal Impacts			558	(558)
Totals	$146,938	$156,525	$124,667	$178,796